

SCIENCE

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KOCH ON BACTERIOLOGY.

THE *Lancet* of Aug. 16, 1890, gives a summary of the address of Koch at the Tenth International Medical Congress, in which he declared that he had not much that was new to tell, but he would make a preliminary communication regarding the result of important new experiments. This communication, a *résumé* of which is published in the *Medical and Surgical Reporter*, had reference to a remedy for consumption discovered by him, which, however, he would not name till his experiments were ended. The rest of his address was an admirably clear account of the progress of bacteriological research.

Only fifteen years ago one regarded the micro-organisms occasionally observed in the bodies of diseased animals and persons more as curiosities than as things essentially connected with the disease; and, considering the great ignorance of their nature which then prevailed, this could not but be so. There were investigators, for instance, who declared bacteria to be crystalloid bodies, not living organisms. With the perfecting of the magnifying instruments, the application of staining, the propagation of organisms on nutritive media, culminating soon in pure cultivation, a rapid change took place. It became possible to distinguish a number of quite definite sorts with certainty, and to ascertain that they were distinctly connected with the diseases in which they were found. It was further ascertained that one sort of bacteria was not transformed into another; and the remarks of old writers on leprosy and consumption, for instance, even justified the conclusion, that just as certain diseases, presumably caused by micro-organisms, had remained unchanged, their germs also must, on the whole, have retained their old qualities. Within certain limits, indeed, deviations of demeanor had been observed in some bacteria, but that was the case among the higher plants too, without the varieties ceasing to belong to the species. The main gain of this period of research was the recognition of the fact that the thing was to discover as many morphological and biological qualities of a bacterium as possible, so as to be guarded against the danger of confounding various bacteria. There was still a danger of this with certain bacteria.—the typhus and diphtheria bacilli, for example,—whereas it had been removed in the case of the tubercle and cholera bacilli by the very exact investigations of these organisms. In their case too, however, the bacillus must never be determined by one mark alone. He had experienced this in his own case, having for some time taken the bacillus of chicken cholera—for the special study of which he had not had material—for a variety of the bacillus of Asiatic cholera, till a new series of experiments had convinced him of his error. Whether the germ of chicken cholera would have an injurious effect on human beings was still a question, and a question that would not easily be answered, as one could not well make direct experiments on human beings, but must wait to see whether the bacillus of chicken cholera would not one day appear in a human cholera patient.

As to the etiological connection of the noxious bacteria with infectious diseases, general opinion was at first against it, and strict proof was necessary. It was necessary to prove in all cases that the disease and the micro-organism always appear together; that the micro-organism in question does not appear in any other disease; and that the micro organism, propagated outside of the body through several generations, always produces the

same disease if it gets into the body again. Now that the etiological connection had been proved in this manner in anthrax, tuberculosis, and erysipelas, and the resistance of opponents broken, one might confine one's self in further cases to the two first lines of proof. This proof had still to be given in the case of abdominal typhus, ague, leprosy, diphtheria, and Asiatic cholera; but in the case of the latter it was already generally assumed that the cholera bacillus was the cause of cholera. As subjects of investigation for the immediate future, Koch designated the question whether the pathogenic bacteria live only in the body, or outside of it too, and in the latter case only occasionally get into the body and cause disease; also the manner of getting into the body and their demeanor there.

The next advance in bacteriology was the discovery of the poisons excreted by the bacteria, which were now regarded as the cause of death in fatal bacterial diseases, for the opinion that the white blood-corpuscles resist the bacteria was more and more losing ground. Koch then discussed the spore-formation of some bacteria, and the influences of air, warmth, moisture, and chemicals on bacteria. Direct sunlight quickly killed bacteria; the tubercle bacillus, for instance. Even daylight produces the same effect, though more slowly. Cultivations of the tubercle bacillus, propagated for from five to seven days at a window, died. Moisture was necessary for the growth of bacteria; moisture, however, on the other hand, hindered their spreading. A bacterium never rose: its transmission took place only by the flying of dust, if it remained for some time capable of life in dry air. By means of improved staining methods some knowledge of the inner structure of bacteria had recently been gained. There seemed to be an inner nucleus of plasma with flagella proceeding from it. In certain infectious diseases—measles, scarlet-fever, and small-pox, for instance—the presence of a pathogenic bacterium had not yet been proved. In hydrophobia, influenza, whooping-cough, trachoma, yellow-fever, cattle-plague, and pleuro-pneumonia of cattle, also, no specific bacterium had been discovered, though the infectious nature of these diseases was evident. And perhaps these diseases were caused, not by bacteria, but by organic parasites belonging to quite another group of animated beings. In the blood of malaria patients protozoa had been found, which were now suspected of causing this and other infectious diseases. Whether protozoa, the lowest representatives of the animal world, really deserved this suspicion, would have to be decided by a method analogous to bacteriological pure cultivation.

But now there remained the question as to what had been the practical utility of all these extremely laborious investigations. The investigator indeed, ought not to inquire after the immediate practical utility of his work. In the present case, however, the question was not entirely devoid of justification. Nor was it quite impossible to give it a satisfactory answer. Had not bacteriological investigation alone led to effective methods of disinfection? The value of water-filtration, the question of the filtering qualities of the soil, of the fitness of surface water for use as drinking-water, of the best method of constructing wells, the sterilization of milk (so important especially for the nutrition of infants), the investigation of the air in schoolrooms and in sewers, the proof of the presence of pathogenic bacteria in the soil and in the air, were all bacteriological questions or conquests.

The diagnosis of isolated cases of Asiatic cholera rendered

timely preventive measures, the discovery of tubercle bacilli rendered timely therapeutic measures, possible. Besides these, indeed, only Pasteur's inoculations against hydrophobia, anthrax, symptomatic anthrax, and swine erysipelas, remained to be mentioned; and the first of these probably did not belong to bacteriology at all, though they had grown on its soil. "But," concluded Professor Koch, "it will not always remain so. Therapeutics proper will also derive benefit from bacteriology; hardly, indeed, for diseases of rapid course, in which prevention will remain the main thing, but certainly for slow diseases, such as tuberculosis. Others also, like Billroth, maintain this hope; but the mistake has frequently been committed of beginning the experiment on human subjects. I regard this as wrong, and look upon the alleged successes of various remedies, from benzoate of soda to hot air, as illusory. For years past I have been seeking means for the therapeutic treatment of consumption, but I began with the pure cultivation of the bacillus. I found a number of substances,—etheral oils, tar-pigments, mercurial vapor, salts of gold and silver, especially cyanide of gold, for instance,—some of which, like the last, even when very strongly diluted, prevent the growth of the bacillus, which, of course, suffices to bring the disease to a standstill. All these substances, however, have proved ineffectual when used against the bacillus in the bodies of animals. I continued my search, however, and found what I sought. Susceptible as the guinea-pig is to the tubercle bacillus, it proved non-inoculable when treated with the substances in question, and even when its disease was far advanced it could be brought to a standstill by this means. This fact may give occasion to search for similar effective remedies in other infectious diseases also, and here lies the field for an international contest of the highest and noblest kind."

EXCAVATIONS IN JUDÆA.¹

THE traveller from Hebron to Gaza cannot fail to be struck with the sudden contrast presented by the mountainous country that he leaves behind him, and the long stretch of almost level plain into which he descends. After passing Bêt-Jibrîn, in which some scholars would see the sight of the ancient Gath, he has to wend his way through narrow defiles and precipitous limestone crags until he suddenly finds himself in the rich plain which forms the *Negeb*, or district of "southern" Judæa. On the first occasion on which I traversed it, however, it was not the sharp contrast between mountain and plain that first attracted my attention: it was rather the number of *tels*, or artificial mounds, with which the plain is covered. Each *tel* marks the site of an ancient city or village; and no archæologist could help reflecting, as he gazed upon them, what a rich field must here await the future excavator. Among them I noted two or three of remarkable height and size, and longed for an opportunity of discovering the historical secrets that lay hidden within them. It was more especially on a lofty mound, which my dragoman told me was called Tel 'Ajlân, that I cast covetous eyes.

The curiosity which the site of the mound excited has now been partially gratified. After ten years of patient importunity, the Palestine Exploration Fund succeeded last spring in obtaining permission from the Turkish Government to excavate in the south of Palestine; and Mr. Flinders Petrie, the prince of living excavators, placed his services at the disposal of the fund. In spite of obstacles of every nature, presented by the climate, by Turkish officialism, and by the character of the Bedouin inhabitants of the country, his few weeks of work have produced truly marvellous results. We now know something of the art and building of the Israelites in the period of the Kings, and even of that older Amorite population whom the Israelites conquered. It has become possible to speak of Palestinian archæology, and to determine the age of the pottery and hewn stones which are met with in the country. Where all before was chaos, order at last has begun to reign.

The firman granted by the Porte allowed excavations to be conducted over an area of 9½ square kilometres in the neighborhood of Khurbet 'Ajlân, but enjoined that all objects found, including

even duplicates, should be handed over to a Turkish commissioner specially appointed to oversee the work. When, however, Mr. Petrie arrived in Jerusalem at the beginning of March, he found, that, owing to a trifling error of description, the firman was detained in Constantinople; and it did not reach Jerusalem, where Mr. Petrie was awaiting it in the midst of violent storms and penetrating cold, until the very end of the month. At last it came, but, in spite of the courtesy and assistance of the enlightened Pacha of Jerusalem, further delays were interposed by the Turkish commissioner; and it was not until April 14 that work could be commenced, one week only before Ramadan. What Ramadan means is known too well to those who have lived in the Mohammedan East. An unbroken fast throughout the day, followed by feasting at night, renders even the most industrious disinclined for work. And Mr. Petrie had to deal with a population naturally disposed to steal rather than to work, and who had never tried their hands at excavating before. It was no wonder that the excavator from time to time thought regretfully of the industrious and intelligent *fellahin* he had left behind in Egypt, and longed to see the "savages" who now squat on the fertile plain of Judæa swept back into their ancestral desert homes.

Mr. Petrie began with some preparatory digging at a place known to the geographers as Umm el-Laqlâq, which has been supposed to be the site of the once important fortress of Lachish. The first time I visited the spot I was told that the real name of the hill-slope was Umm el-Latîs; and three years ago, when I visited it for a second time, I satisfied myself that it represented nothing more than the site of a village of the Roman age. Mr. Petrie's excavations have abundantly confirmed my conclusion. The site, he found, was covered with only six to eight feet of artificial earth, which was filled with fragments of Roman pottery, and in one place a worn coin of Maximian Hercules was disinterred two feet above the virgin soil. Accordingly, he soon moved with his workmen to the *tel*, which formed the most prominent object in the district where he was permitted to dig.

The *tel* is about six miles from the village of Burêr, and near the site of a Roman hamlet which goes by the name of Khurbet 'Ajlân, or "Ruin of Eglon." It proves not to be called Tel el-'Ajlân, "the mound of the Eglonite," as my dragoman informed me, but Tel el-Hesî, apparently from a spring of water which flows past the eastern face of the mound. The spring is the only source of fresh water that exists for many miles around, and falls into a brackish brook which trickles from the neighboring Tel en-Nejîleh, the united stream being subsequently swallowed up in a stony *wadi* a few hundred yards lower down. Mr. Petrie is doubtless right in thinking that it was to this spring that the city now represented by the Tel el-Hesî owed its importance. The spring would have borne the same relation to the old town that the spring of the Virgin bore, and still bears, to Jerusalem. When swollen by rain, the stream is capable of doing a considerable amount of mischief. It has washed away a large portion of the eastern and south-eastern sides of the mound, thus laying bare a section of the *tel* from its top to the bottom. This has proved, however, of invaluable service to the explorer, as the time at his disposal would never have allowed him to uncover a tenth part of the soil which has been removed by the water. Another season of work would have been needed before the lowest part of the *tel* could have been reached, and the history of the mound revealed, together with that of the pottery which is embedded in it. The kindly assistance of the water was the one piece of good fortune that fell to Mr. Petrie's lot, and he knew how to make the most of it.

On the southern and western sides of the *tel* is an enclosure, about thirty acres square, which is surrounded by a "clay rampart" still seven feet high in certain parts, and in one place by a brick wall. As there is but a slight deposit of earth within the enclosure, while nothing was found in it, Mr. Petrie is doubtless right in holding that it was intended to shelter cattle in case of an invasion. It probably belongs to the later period of the city to which it was attached.

The city is represented by the *tel* or mound. This rises to a height of no less than sixty feet, formed by the accumulated ruins of successive towns, the lowest of which stood on a platform of

¹ Article by A. H. Sayce, in *The Contemporary Review* for September.

natural soil about fifty feet above the stream which runs through the *wadi* below. The mound is about two hundred feet square.

Mr. Petrie's description of it reads like the record of Dr. Schliemann's discoveries at Troy. City has been piled upon city, the latest colonists being Greeks, whose settlement was itself swept away before the age of Alexander the Great. The lowest and earliest city was the most important, if we may judge from the size of the wall with which it was encircled. This was 28 feet 8 inches thick, and was formed, like the walls of an Egyptian city, of clay bricks baked in the sun. It had been twice repaired in the course of its history, and it still stands to a height of twenty-one feet. As thin black Phœnician pottery was found above it, which Egyptian excavation has shown to be not later than about B.C. 1100, we may follow Mr. Petrie in regarding the wall as that of one of those Amorite cities which, as we are told, were "walled up to heaven" (Deut. i. 28). It is the first authentic memorial of the ancient Canaanitish population which has been discovered in Palestine. As large quantities of potsherds have been met with both outside and within it, we now know the precise characteristics of Amorite pottery, and can consequently tell the age of a site on which it occurs.

The city to which the wall belonged was taken and destroyed, and the wall itself was allowed to fall into ruin. Then came a period when the site was occupied by rude herdsmen or squatters, unskilled in the arts either of making bricks or of fortifying towns. Their huts were built of mud and rolled stones from the *wadi* below, and resembled the wretched "shanties" of the half-savage Bedouin, which we may still see on the outskirts of the Holy Land. They must have been inhabited by members of the invading Israelitish tribes who had overthrown the civilization that had long existed in the cities of Canaan, and were still in a condition of nomadic barbarism. We may gather from the Book of Judges that the period was brought to an end by the organizing efforts of Samuel and the defeat of the Philistines by Saul. With the foundation of the Israelitish monarchy came a new epoch of prosperity and culture. Jerusalem and other cities were enlarged and fortified (1 Kings ix. 15-19), and the Chronicler tells us (2 Chron. xi. 5) that after the revolt of the Ten Tribes the chief cities of Judah were further strengthened by Rehoboam. The ruins of Tel el-Hesi furnish numerous evidences of this new epoch of building. First of all, we have a wall of crude brick thirteen feet thick, which is probably identical with a wall traced by Mr. Petrie along the western and northern faces of the *tel*, where it ends in a tower at the north-west corner. However this may be, the section laid bare by the stream on the eastern face of the *tel* shows that the thirteen-foot wall was repaired and rebuilt three or four times over. All these rebuildings must be referred to the age of the Kings, since the only remains of post-exilic times discovered on the mound are those of the Greek settlement of the fifth century B.C.

One of the later rebuildings is illustrated by a massive brick wall twenty-five feet thick, and of considerable height, which Mr. Petrie has discovered on the southern slope of the *tel*, and which he refers to the reign of Manasseh. It has been built above a *glacis* formed of large blocks of stone, the faces of which were covered with plaster. Mr. Petrie has traced the *glacis* to a height of forty feet, and has found that it was approached by a flight of steps, at the foot of which, in the valley, was a fortified building, of which only the gateway now remains. The earth on which the *glacis* rests is piled ten feet deep around a large building eighty-five feet in length, and composed of crude brick walls more than four feet in thickness. Ten feet below the building are the ruins of another large building, which, after having been burned, was rudely put together again out of the old materials. The original edifice was of crude brick, with doorways of "fine white limestone." Several slabs of the latter have been discovered. On three of them is "a curious form of decoration by a shallow pilaster, with very sloping side, resting on a low cushion base, and with a volute at the top." As Mr. Petrie remarks, "we are here face to face at last with work of the earlier Jewish kings, probably executed by the same school of masons who built and adorned the Temple of Solomon." In the volute Mr. Petrie sees a representation of a ram's horn, and calls to mind the biblical expres-

sion, "the horns of the altar." Whether this be so or not the volute is an earlier form of that which characterizes the Ionic capital. On one of the slabs is a *graffito*, which must have been scratched upon the stone by one of the subjects of Solomon or his immediate successors. It represents a lion or dog walking; and, as the slab was built into the reconstructed edifice upside down, the drawing must have been made while the stone still formed part of the original edifice. This can hardly have been erected at a later date than the reign of Rehoboam.

The stones of the *glacis* have led Mr. Petrie to a very important conclusion. They are draughted, the surface of the stone being smoothed away towards the edges so as to leave a rough projection in the middle. But they show no trace of the claw-tool, or comb-pick, as Mr. Petrie prefers to call it. Now, this tool is characteristic of Greek work; and as it was used in Greece in the pre-Persian era, while it was introduced into Egypt only after the contact of Egypt with Greece, we may infer that it was of Greek invention. Its employment in Palestine, therefore, would imply that any building in which it was used belonged to the Greek age, Mr. Petrie's excavations at Tel el-Hesi having shown that older Jewish work exhibits no traces of it: consequently the dispute as to the age of the Harâm wall at Jerusalem is at last settled. Here the stones have been dressed with a claw-tool from the foundation upwards, and it becomes clear, accordingly, that they must all be referred to an Herodian date. I have always felt doubtful about the antiquity commonly ascribed to them on the strength of certain masons' marks pronounced by Mr. Deutsch to be early Phœnician characters. But it is questionable whether they are characters at all: at any rate, they do not belong to an early form of the Phœnician alphabet, and no argument can be drawn from them as to the pre-exilic origin of the monument on which they occur.

But while the date of the great wall which surrounds the Mosque of Omar at Jerusalem is thus brought down to the classical period, the very fact which has reduced its claims to antiquity has served to establish the pre-exilic character of another monument near Hebron. This is the Râmet-el-Khalîl, or "Shrine of Abraham," about three miles to the north of Hebron. The huge blocks of stone of which this building was composed have never been touched by the claw-tool, and we may therefore see in them the relics of a temple the foundation of which must be older than the exile. Can it represent the site of Kirjath-sepher, the Canaanite "city of books"?

In Tel el-Hesi Mr. Petrie sees the ruins of Lachish.¹ The spring which flowed beneath its walls is, as has been said, the only fountain of fresh water which gushes from the soil for many miles around; and the spot would naturally, therefore, have been selected as the site of an important fortress. How precious such a supply of water would be may be judged from the fact that the brackish stream which flows from the smaller and more insignificant Tel en-Nejileh was in ancient times confined there by a massive dam. We know that Lachish was one of the chief fortresses of Judæa, and its capture by Sennacherib was considered sufficiently memorable to be depicted in a bas-relief on the walls of that monarch's palace; we know also that it stood somewhere in the neighborhood of the present Tel el-Hesi. On the other hand, the name of Khurbet 'Ajlân, given to an adjoining site, might incline us to believe that the *tel* represents Eglon rather than Lachish. Eglon and Lachish, however, were close to one another, and, considering that Lachish was the larger and more important town of the two, Mr. Petrie is probably right in locating it at Tel el-Hesi. In that case Tel en-Nejileh will be Eglon.

If Tel el-Hesi is Lachish, the monuments of sculpture and inscription overthrown there by Sennacherib must still be lying within its ruins. Indeed, even more precious relics of the past may await the explorer of the old Amorite city. Among the tablets discovered at Tel el-Amarna are despatches to the Egyptian king from Zimridi and Yabniel, the governors of Lachish, which prove that the art of writing the Babylonian language in cuneiform characters upon clay was known and practised there. The city was the seat of a governor, and it is reasonable to suppose

¹ Major Conder had already suggested the same identification (Memoirs of the Survey of Western Palestine, iii. p. 261).

that the governor's palace contained an archive chamber. For aught we know, the clay tablets with which the archive chamber was once stored may still lie buried under the *débris* which has concealed the ruins of the Amorite city for so many generations from the eyes and ravages of man.

However this may be, Mr. Petrie's excavations, brief and imperfect as they have necessarily been, have taught us two important facts. The first of these facts is the mutability of local nomenclature in the East. The recurrence of an ancient name in the mouths of the modern inhabitants of Palestine by no means implies that the place to which it is given is the representative of an ancient locality of the same name. The utmost it can prove is that the ancient site is probably to be sought in the near neighborhood of the spot to which the name is now applied. The existence of a name like Khurbet 'Ajlân, given though it may be to a comparatively recent site, may yet show that the Eglon of the past once stood somewhere in its vicinity. But it can do no more. The tides of war which have swept from time to time over the civilized East have displaced the older population, have reduced the earlier cities of the land to "ruinous heaps," and have transferred their inhabitants to other places. When the Jews returned from the Babylonian exile, they were in most cases likely to settle in the open country, at a distance from the barren mounds which were all that remained of the older cities. The new Eglon would arise, not on the site of the more ancient one, but where the settlers would be surrounded by green pastures or cultivated fields. The fact is a warning to those who would place the ancient Megiddo at Mujedda on the evidence only of a similarity of name, or who would transform the "Stone" of Zohemoth into the Cliff of Zehwele, in defiance of philology and geography.

The second fact brought to light by Mr. Petrie is, that, if we are ever to learn any thing about pre-exilic Israel on the soil of Palestine itself, it must be by the help of the spade. His excavations have shown that up to now we have known nothing, or next to nothing, of the archaeology of the Holy Land before the classical age. They have further shown what a rich harvest, on the other hand, awaits the excavator. Already the basis has been laid for a scientific study of Palestinian antiquities; the sites that cover the ground can now be assigned to their respective ages by means of the pottery they contain; and we can tell from a simple inspection of the stones of a building whether or not it belongs to the pre-exilic epoch. The future excavator will no longer set to work in the dark, trusting for success to chance and luck: he will know beforehand where and how to dig, and with what rewards he is likely to meet. The explorer who will devote himself to the labor, as Sir A. H. Layard devoted himself to Nineveh and Dr. Schliemann to Troy, will obtain results as marvellous and far-reaching as those obtained by Layard and Schliemann. The former story of Palestine has not been obliterated from its soil, as has often been imagined: on the contrary, it is indelibly impressed on the stone and clay which that soil still holds in its bosom. We have dug up Homer and Herodotus: we shall yet dig up the Bible.

Mr. Petrie's excavations could not be continued long enough to allow him to penetrate to that central core of the *tel* where alone he could expect to meet with inscribed stones. Apart from stonemasons' marks, in the shape of early forms of Phœnician letters, the only inscription he has disinterred is scratched on the fragment of a terra cotta vase. The inscription he assigns to the age of Hezekiah. One of the letters composing it, however, has a very archaic form, and it may therefore belong to an earlier period. But, like the famous Siloam inscription, it indicates in a curious way what was the ordinary writing-material employed by the Jews. The "tails" of certain letters are curved, the curve being represented on the refractory terra cotta by two scratches, which together form an angle. It is clear from this that the Hebrews must have ordinarily written on papyrus or parchment, where the longer lines of the characters would naturally run into curves, and not, like the Moabites, for instance, on clay, stone, or metal. They were a literary rather than a monumental people.

A seal found in Jerusalem, and belonging to Mr. Clark, has at last given us a clew to the relative age of the few Jewish inscriptions of the pre-exilic period which are at present known to us.

The inscription upon it states that it was the property of "Elishama", the son of the King." Now, we hear about this Elishama' from the prophet Jeremiah (xli. 1), who tells us that he was of "the seed royal," and the grandfather of Ishmael, the contemporary of Zedekiah. Elishama', accordingly, will have flourished about B.C. 650, and we can therefore now determine what were the forms taken by the letters of the Jewish alphabet at that particular time. Comparing them with the forms of the letters in the Siloam inscription, we find that the latter must be somewhat, though not greatly, older, and that consequently the general opinion is justified which considers that the construction of the tunnel commemorated by the inscription was a work of Ahaz or Hezekiah. A fixed point of departure has thus been obtained in Hebrew epigraphy.

The excavator, then, who continues Mr. Petrie's work next season will be equipped with knowledge and resources which, only six months ago, were not even dreamed of. Discoveries of the highest interest await him,—monuments of David and Solomon and their successors; it may be even the clay records of the Amorite priests and chieftains whom the children of Israel dispossessed. The bearing such discoveries may have upon the interpretation and criticism of the Old Testament Scriptures, the light they may throw upon the conquest of Canaan or the establishment of the Davidic monarchy, cannot even be conceived; but we may feel sure that such discoveries will be achieved, if only the means of achieving them are provided: and provided we cannot doubt they will be, as soon as the results of Mr. Petrie's preliminary campaign are made known to scholars and lovers of the Bible. In wealthy England the Palestine Exploration Fund cannot fail to find that money for the work will flow to it in abundance.

SUGAR AND THE SUGAR-CANE IN CUBA.

M. TRUY, French consul at Santiago de Cuba, says, according to the *Journal of the Society of Arts*, London, that the cultivation of the sugar-cane in the eastern portion of the Island of Cuba is almost entirely confined to the districts of Santiago, Guantanamo, and Manzanillo. This cultivation, although it has experienced some extension of late years, is not in the flourishing condition it was twenty years ago. This falling-off is due to the civil war, which ruined many planters and discouraged others. The profits, however, realized for some time past by those planters who had sufficient credit, or confidence in the future, to continue to engage in this industry, have given a stimulus to the cultivation of the cane. Sugar-factories have been established in many parts, particularly in the district of Guantanamo and Manzanillo; old sugar-factories have been supplied with fresh plant; and many planters, encouraged by the high prices recently realized, have hastened to get their ground ready for cultivation. Part of the products of the province of Santiago is shipped to Spain, and some small quantity is consigned each year to Canada; but the United States absorbs almost the whole of the yield of the island. The Cuba market was some years ago controlled by French merchants, who owned the greater part of the sugar-factories of the province; but since the civil war many planters sold their estates, and retired to France. A few estates, however, are still owned by Frenchmen, at Guantanamo especially. Those known as Sainte Marie, Sainte Cecile, and San Antonio are directed or owned by Frenchmen. All the land in the island is, in general, fit for the cultivation of the cane, an even surface being generally chosen with a view to facilitate the working and the harvesting. The ground should also be as near the sea as possible, so as to avoid the cost of carriage and transport, which is particularly high in that part of the island, where it may be said there is an absence of railroads, and the carriage roads are in a deplorable condition. If the ground chosen is one that has hitherto been uncultivated, the planter, first of all, clears it in cutting down the branches of the trees and small shrubs with the *machete*, and burning the larger trees. The expenses of these preliminary operations may be estimated at from four hundred to five hundred dollars per plantation of thirteen hectares (the hectare is equivalent to 2.47 acres). Holes are then dug at intervals of from three to four feet, and in them are placed hori-

zonally pieces of cane of a length from two to three joints. If the ground has previously been under cultivation, the methods differ. The ground must first of all be ploughed, and furrows are then made in which entire canes are stretched *à chorros*; that is to say, end to end horizontally. The plants are then covered with earth. The sugar-cane is frequently planted in the spring, but many planters are of opinion that plantations in Cuba sown in winter give a much better yield. The young plants are allowed to shoot for ten or eleven months if they have been planted in the spring, for fourteen or sixteen months if planted in the winter, and the harvest then takes place. There are in the island several varieties of sugar-cane,—the white or Otaheite cane, the twisted white cane, the twisted violet cane, and the so-called black cane. The first two varieties are the only ones cultivated at Cuba. The white cane is prepared for planting in virgin soil, and gives a good yield. The crystalline is reserved for old plantations: it is better adapted to resist the long drought than the white variety. The cultivation of the last three species of sugar-canes has been abandoned on account of their insufficient yield. Before the abolition of slavery, the planters themselves cultivated their fields; since that period, however, they have experienced the greatest difficulty in obtaining a sufficient number of hands to harvest their canes. Many planters, in consequence, deemed it advisable to divide their labor between a certain number of colonists, who are bound to cultivate each his plot of ground, to plant the canes, to cut them at harvest time, and to carry them to the factory, where they receive, after the sugar is turned out, a certain proportion of the quantity of the sugar extracted from the canes harvested on their allotments. Cuban sugar is generally prepared for export. The special quality intended for home consumption is clearer and finer than that shipped abroad.

THE UNIT MEASURE OF TIME.¹

I DESIRE at the opening meeting of this section of the Royal Society to bring to your attention a subject of some general importance.

For a number of years past attempts have been made on both sides of the Atlantic to effect a reform in the method of reckoning time. The degree of success which has attended the movement is a matter of surprise when we consider that the changes involve a departure from the usages of society, and are in opposition to the customs of many centuries.

The modern introduction of rapid means of communication has created conditions of life different from those of preceding generations. It may be said that until a few years back, localities separated by a few miles of longitude were assumed to have distinct and separate notations of time. When many localities were first brought into close relations by the establishment of a line of railway, the different local times (so called) with which the railway authorities had to deal produced much confusion. In order to attain security for life and property in operating the line, and likewise to promote the convenience of the public using it, it became necessary to observe a uniform notation, which received the name of "railway time;" that is to say, the many local reckonings which prevailed at the numerous points between the two termini were reduced to a single reckoning common to the many localities.

As lines of railway multiplied, the unification of the reckoning of time became more indispensable, and it early came to be seen that the benefits to result from unification would be in proportion to the extent of territory embraced within its operations. At length it became obvious that uniformity of reckoning might with advantage be extended to a whole continent or the whole globe. Investigation also established that such an extension would contravene no law of nature, or principle of science.

The proposal to supersede the numberless local times by a single notation, synchronous in every longitude, had a somewhat Utopian aspect. Many, indeed, regarded it as a revolutionary innovation, for it came into direct conflict with the customs and the

habits of thought which had descended from a remote antiquity. Nevertheless, the potent agencies steam and electricity, which have co-operated in making astonishing transmutations in human affairs, have forced on our attention the investigation of time and its notation, and demanded some change to meet the altered circumstances of daily life.

If we consider the nature and attributes of that which we know as time, we will find that it is wholly independent of material bodies, and uninfluenced by space or distance; that it is essentially non-local and an absolute unity; that it is not possible for two times to co-exist, or for time to be divided into two parts having a separate entity, in the sense that material things can be divided. This view of time incontrovertibly established, there is no ground for the theory that there are many local times. We may therefore sweep away the ordinary usages based on that theory as being unsound and untenable, and the way is made clear for a comprehensive system of time-reckoning to embrace the whole globe.

About fourteen years ago the effort was first made to introduce a reform which would satisfy the requirements of the age. Whatever system might be adopted, it was felt that it should be based on the fundamental principle that there is only one time. It was, moreover, held to be expedient that there should be only one reckoning of time common to all nations; and, to secure a common reckoning, one established zero and one common unit of measurement became necessary.

With the attainment of these objects in view, preliminary discussions took place at the meetings of several scientific associations in Europe and America, and it was held that in a matter of such widespread importance the unit of time should be a measure which could be readily referred to as a perpetual standard for the use of the entire human family. It was likewise felt desirable, if not indispensable, that all nations should acquiesce in its recognition.

It was accordingly proposed at an international geographical congress at Venice in 1881, and confirmed at a geodetic congress at Rome held two years later, that the government of the United States should be invited formally to call a conference of representatives, to be specially appointed by the governments of all civilized nations, to consider the subject, and determine the zero and standard of reckoning to be used in common throughout the globe.

Six years ago this conference assembled, under the auspices of the United States, in the city of Washington, the governments of twenty-six nations sending fully accredited delegates. Their deliberations extended over the month of October, 1884. With substantial unanimity they passed a series of resolutions, in which the unit of measurement was constituted, and they recommended that time be computed according to the solar passage on a recognized zero meridian of the earth's surface.

The resolutions of the Washington conference thus authoritatively established the fundamental principles which underlie the scheme for a general unity of time-reckoning; each nation being left in its discretion to accept the details of the reform whenever deemed expedient in each individual case. To facilitate the acceptance of the new system, the circumference of the globe has been divided into twenty-four sections, the reckoning in each section being based on a standard subsidiary to, but directly related to, the unit measure. In the twenty-four subsidiary standards thus constituted the hours are simultaneous, although differently numbered in accordance with the longitude of the several sections. With the single exception respecting the numbers by which the hours are locally to be known, there is complete identity in every subdivision of time throughout the twenty-four sections. The many local days which follow in succession during each diurnal period are by this arrangement reduced to twenty-four normal days, each differing an hour in its commencement from the day which it succeeds. Twelve of these normal days precede, and twelve follow, the primary standard or unit measure of time, which is the mean of the whole series of normal days. By this expedient, which has received the name of "the standard time system," the means have been provided by which all nations, without any apparent great departure from old usages, may observe substantially the one common reckoning.

¹ Address at the opening of Section III. of the Royal Society of Canada, by the president, Dr. Sandford Fleming, May 27, 1890.

The adoption of the system of standard time has already made considerable progress. In North America, standard time was first introduced in railway economy: it has since been generally accepted by the mass of the community. In Asia the same system has been legally established throughout the Japanese Empire. In Europe a general interest has been awakened on the subject; and at the present moment it attracts special attention in Austria-Hungary, Germany, and Belgium. Late advices give expression to the belief that standard time will be adopted by the railway service of these countries before many months. It is already observed in Sweden and Great Britain.

Thus, at the present day, standard time has been fully accepted in Asia by not less than forty millions of people, in Europe by almost an equal number, in America by more than sixty millions; and there is scarcely a doubt that in no long period it will be in use throughout the greater part of central Europe, making a total number of probably two hundred and thirty millions of the most progressive peoples in the three continents who will have accepted the principles of reckoning based on a common unit. Without taking into account central Europe, where the reform is on the eve of adoption, the unification of time-reckoning has so far advanced, that in Japan, Belgium, Sweden, England, Scotland, Canada, and the United States, all well regulated clocks strike the hours at the same moment (although locally the hours are distinguished by different numbers), and the minutes and seconds in all these countries are absolutely synchronous.

The unit of measurement authoritatively established by the resolutions of the international conference of 1884 is the basis of the system by which these results have been obtained; and we must regard this new system as the one which shall hereafter be observed by the great mass of the civilized inhabitants of the world in their daily reckonings and in their chronology. It is of first importance, therefore, that no doubt or ambiguity should exist in connection with it. By the resolutions of the conference of 1884, the unit measure may be defined as the interval of duration extending from one mean solar passage on the anti-meridian of Greenwich to the next succeeding passage. This standard unit has been variously designated as follows; viz., 1. A Universal Day, 2. A Terrestrial Day, 3. A Non-Local Day, 4. A Cosmopolitan Day, 5. A World Day, 6. A Cosmic Day.

It requires no argument to show that no one of these six terms is appropriate. The unit of time is not a day in the ordinary sense: it is, indeed, much more than an ordinary day. According to our habit of thought, a day is invariably associated with alternations of light and darkness; and each day, moreover, has a definite relationship to some locality on the surface of the earth. The day, as we commonly understand it, is essentially local; and during each rotation of the globe on its axis, occupying a period of twenty-four hours, there are as many days as there are spots on sea and on land differing in longitude. These numberless days are separate and distinct, each having its noon and midnight, its sunrise and sunset. The time-unit is an entirely different conception: it is equal in length to a day, and must, from its nature, be synchronous with some one of the infinite number of local days. By the resolutions of the Washington conference, it is identified with the civil day of Greenwich. But while the latter is simply a local division of time, limited to the Greenwich meridian, the unit measure is, on the other hand, not so limited: it is equally related to all points on the earth's surface in every latitude and longitude. Under this aspect, the wider functions and general character of the unit measure remove it from the category of ordinary days, as we understand the familiar expression; and, to obviate all doubt and uncertainty regarding it, it is in the highest degree desirable that the universal time-unit should be distinguished by some appellation by which, apart from its local relationship, it may always be indisputably known.

It was Lord Chief Justice Coke who said that "error is the parent of confusion." As the primary object of time-reform is to obviate confusion, we should take every precaution to preclude error. Is it not, therefore, expedient that we should adopt means to secure a proper and appropriate designation for the unit measure, and abandon as misnomers each one of the terms which have hitherto been applied to it? In a paper on the subject of time-

reckoning, published in the "Transactions" of this society in 1886, the unit measure is defined, its uses described, and it is likewise pointed out that its distinctive appellation remains undetermined. I consider it to be my duty to draw attention to the want; and, while it would be an act of presumption on my part to propose a name, I will venture the remark that in the general interests of science an effort should be made to supply it. It has been found expedient to derive technical terms from a classical etymology, and I beg leave to suggest that the same rule might be followed in this case with obvious advantage. Whatever name be chosen, if derived from a Greek or Latin root, the word would in all countries have the same definite meaning, and could readily be incorporated into all languages. If such a word be adopted as will clearly express "a unit measure of time," it will gradually come into general use, as in the parallel cases of "telegram," "telegraph," "photograph," "lithograph," etc.; and by this means all nationalities will be enabled to give expression to one and the same meaning when they refer to time-reckoning in its broad significance.

I humbly submit that the Royal Society of Canada will confer a general benefit, and act becomingly, by taking the initiative in obtaining an appropriate designation for the unit measure of time.

If that view be concurred in by this section of the society, I respectfully suggest that a special committee be appointed to consider the subject, with instructions to report during the present session.¹

NOTES AND NEWS.

A LABORATORY for plant-biology has been recently opened at Fontainebleau, says *Nature* of Sept. 11. It is under the direction of M. Bonnier, professor of botany at the Sorbonne in Paris, to whom application should be made by any contemplating research there.

—In the London *Times* for Sept. 9 we read the following note on how to keep salt dry: "The Dutch Indian Government offers a prize of 10,000 fl. for the best practical answer to the question 'In what manner should the salt which is sold in Dutch India in small packets be packed up so as to keep dry?'"

—The fifty-ninth annual exhibition of the American Institute of this city will open on Oct. 1, and continue until the end of November. The institute's exhibition building covers the large block of ground between Second and Third Avenues and 63d and 64th Streets, affording ample space for a display which is looked forward to with increasing interest from year to year.

—A wonderful example of erosion may be seen in the illustration to Professor Michie Smith's article on the eruption of Bandaisan in the *Proceedings of the Royal Society of Edinburgh*, vol. xvii. p. 70. The valley there depicted was produced by the erosive power of a small stream within the short space of ten months. Its depth, when Professor Smith visited the neighborhood, was 80 feet, and in some places little short of 150 feet.

—It is a fact known to few, that Russia has taken a place among the quicksilver-producing countries. We note in *The Scottish Geographical Magazine* that this metal is at present extracted at two places,—near the village of Kurush in Dagestan; and near the village of Saizef, in the district of Bachmut in Ekaterinoslav. At the former place the ore is said to contain the enormous proportion of 74.7 per cent of quicksilver. At Saizef, where the ore contains only 0.32 to 4.5 per cent, the pure metal extracted in 1889 weighed 164½ tons. Diamond-boring has lately been adopted, and a fairly rich lode of cinnabar has been struck at a depth of 260 feet.

—The special committee of Section III. of the Royal Society of Canada, to whom the expediency of suggesting an appropriate name for the unit measure of time was referred, reported as follows at the general meeting of the society held May 29, 1890: "The committee recognizes the advisability of obtaining a suitable nomenclature, and concurs in the views expressed in the address of the president of the section as to the expediency of

¹ This report is given elsewhere as a note.

some steps being taken by the society; the committee is likewise of opinion that we must seek in the classical languages for the material to construct an appropriate word, which will command the acceptance of every nationality. The committee conceives, that, whatever may be the individual opinions of members of this society, it is not at present expedient to do more than draw attention to the requirement. Your committee therefore recommends, that, in the name of the Royal Society of Canada, correspondence be opened with sister societies in other parts of the world with the view of bringing the subject to their notice, asking the favor of an expression of opinion regarding it. The committee recommends that the council be requested to take such steps as may be deemed expedient to bring the subject to the attention of sister societies."

—At a special meeting of the Geographical Society of Paris held on the 28th of June, M. Fernand Foureau gave an account of his journey to In-Salah, undertaken in pursuance of a mission intrusted to him by the ministers of public instruction and commerce. As related in the "Proceedings of the Royal Geographical Society," London, the traveller started from Biskra. At Ain-Taïba he crossed the route of M. Leon Say in 1878, and of the first expedition of Col. Flatters. Continuing to the south-west, he traversed the region of the Erg. The chains of sand-dunes here attain an elevation of 1,200 feet, and are separated by "gassis" 20 to 30 miles in length, and $\frac{3}{4}$ to $1\frac{1}{2}$ miles in breadth, which broaden farther in the interior. Vegetation at the foot of the dunes is green and abundant. A species of tamarisk is found on the summits. At the Ued Auleggi, M. Foureau struck the route of the second Flatters mission. Ascending an affluent of this Ued, he reached the watershed (about 1,200 feet high) between the basins of the Igharghar and the Ued Massin. The next range of importance, that of the Baten, running in a north-east and south-west direction, forms the edge of a deeply eroded plateau. The traveller here turned to the north east, and skirted the region of the Erg, exploring the estuaries of the numerous streams which descend from the Tademayt. These estuaries are covered with small shrubs and plants; but the expedition found their beds completely dried up, owing to the absence of rain for the last two years. The principal geographical results of this expedition are as follows: M. Foureau has determined the latitudes and longitudes of thirty-five points, and taken barometrical observations along the entire route. The length of his itinerary was over 1,500 miles, 600 of which were beyond the frontier of South Algeria. M. Foureau has shown that between Uargla and In-Salah there is a practicable route for a railway, on a firm soil, without a dune along it.

—Professor Klossovsky of Odessa has been investigating the physical characteristics of the Black Sea, as we learn from *The Scottish Geographical Magazine*. He finds its area, including the Sea of Azov, to be 147,100 square miles. Its greatest depth lies between Sevastopol and Constantinople, and is considerable for an inland sea, being 1,166 fathoms. The salinity on the north-west coast is 1.43 per cent, in the open sea 1.76, and at great depths 1.9, whereas in the Mediterranean and in the Atlantic, in the region of the trade-winds, it is 3.7 per cent. The temperature of the air over the surface of the sea is in summer about 72°. In the winter months it rises towards the southern shore, varying in January from 35½° on the northern shore, to 43° on the coast of Asia Minor. In summer the prevailing winds blow from the land towards the sea; in winter, in the opposite direction. The Black Sea is restless and stormy, for strong winds and gales blow over its shores on ninety days in the year. Professor Klossovsky gives full details concerning the variations of the level of the sea, having obtained records of observations made at nineteen stations during seventeen years. In the summer months the water near the shores stands above, in the winter months below, the mean level. The monthly mean of these variations is only one foot, but the absolute differences of level are very great,—in Taganrog nearly 14 feet 4 inches. The mean level for the year is nearly constant. Professor Klossovsky considers that these variations are independent of the rainfall, and are due to variations of atmospheric pressure, winds blowing from the land depressing the surface of the sea. It might, then, be expected that a rise of the water on

one side of the sea would be accompanied by a sinking on the other side, and observations prove that such is the case. In summer the water is subject to sudden changes of temperature, sometimes amounting to fourteen or fifteen degrees in a day. This may be caused, partly by the action of the waves in mingling together the upper and lower strata, and partly by the winds, which, blowing off shore, sweep away the warmer surface water.

—The Rev. Dr. Norman has just returned from a dredging expedition in the Varanger Fiord and Sydvaranger, says *Nature* of Sept. 11. He has been absent nine weeks, and has brought home extensive collections in all branches of marine *Invertebrata*. The fiords of Sydvaranger were found to possess a rich fauna, with depths descending to 120 fathoms. These fiords had never before been scientifically investigated, though Baron de Guerne took a few hauls of the dredge there in 1881, when on board the French vessel "Coligny" as a member of the Mission Scientifique en Laponie, and published a list of the *Mollusca* obtained.

—A new method of measuring the inductive power and conductivity of dielectrics has been described by M. Curie in the *Annales de Chimie et de Physique*. It is based on the use of an apparatus he calls the piezo-electric quartz. He has studied with it, as we learn from *Nature* of Sept. 11, those qualities in various crystalline dielectrics; and he enunciates a law of superposition, which shows the independence of the effects produced by different variations of electro-motive force. Quartz shows a difference of conductivity in the direction of the optic axis (where it is strong), and at right angles (where it is insensible); and this gives rise to striking phenomena. Plates parallel to the axis, and with the extremities of the axis communicating with the earth, behave, beyond 120°, as dielectrics of zero inductive power. With prolonged heating, the conductivity along the axis quite disappears. Water plays a capital rôle in the conductivity of a great many dielectrics, possibly in all. With plates of baked porcelain kept moist, the various types of conductivity could be reproduced. The electro-motive forces of polarization of moist porous bodies may attain several hundred volts.

—The United States consul at Mannheim, Germany, says that in Mannheim and the neighborhood there are several large factories worked by steam, with enormous machines employing hundreds of hands, engaged in preparing feathers for market. The feathers, says the *London Journal of the Society of Arts*, come in great quantities from Russia, Austria, and other parts of Europe, and also Asia, China especially sending vast quantities in a very dirty condition. The feathers come into the factory in large bales. These are opened near a kind of gin or breaker, which separates the feathers from a lumpy or buncy form, and flings them around in an air-filled chamber, through which a constant current is blowing. From this machine they go to another, in which, by means of ventilators, a separation of the short and light feathers from the long and heavy is made. Stage after stage, through machines arranged and shaped much like cotton-gins, the feathers fly, each machine separating the lighter from the heavier, until the most delicate, flaky snow-down is flung out into a large chamber. In one stage of the process the feathers are cleansed. This is done by placing them in a large steam-heated boiler, into which steam is projected, and made to cleanse every particle of dirt from the feathers. Long before the feathers get time to be wet through by the steam, dry air is injected from one side, while suction currents draw off every particle of dust or dirt loosened by the steam. The largest feathers, those which on account of the long quills are unfitted for use, are sent to the State prisons, where for very small sums the "wings" are carefully torn from the quills and returned to the factory, where they are cleansed and prepared for market. Most of the factories endeavor to get out of the feathers as much as possible of the down. A very fine quality of this article, that of the eider duck, fetches about \$3.50 a pound. The machines are very simple in character and construction, and require in their working no special skill. They consist of breakers and ventilators. Contrivances for catching dust have been invented, but never any so skilfully contrived as to keep the fine particles from finding their way into the open rooms, and thence into the lungs of the work-people.

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Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

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IMPERIAL UNIVERSITY OF JAPAN.

INASMUCH as the Teikoku Daigaku, or Imperial University, owes its existence to the union of the late Tōkyō Daigaku and Kōbu Daigakkō, it seems fitting, that, in tracing its history, reference should be made to the origin of these two institutions.

The four departments of law, science, medicine, and literature, which composed the Tōkyō Daigaku, sprang, with the one exception of the department of medicine, from an institution of some antiquity, founded by the Tokugawa Government, and known first as the Yōgakujo, and afterwards as the Kaiseijo. This institution was, after the restoration of 1868, revived by the Imperial Government, and in January of the following year it opened its doors anew for the first time. Special attention was devoted to instruction in English and French, to which languages German was soon afterwards added. In December of the same year the college received the name of "Daigaku Nankō," or South College, because of its location at Hitotsubashi to the south of the central Daigaku, to which it was attached. The central Daigaku was situated in the old Gakumonjo at Yushima.

The Daigaku having been abolished in the year 1871, the Daigaku Nankō, known simply as the Nankō, came directly under the control of the department of education; and in the following year, when the country was mapped out into educational districts, it

received the name of the "First Middle School of the First Grand Educational District."

In April of 1873 the name of the institution was changed to "Kaisei-Gakkō," and special courses of studies were instituted in law, chemistry, engineering, polytechnics, and mining. In the same year the institution was transferred to the new buildings just completed at No. 1 Nishikichō Sanchōme (Hitotsubashi Soto). In 1874 the word "Tōkyō" was prefixed to the name of the institution, and it was called the "Tōkyō Kaisei Gakkō." In April of 1876 the department of education united this institution and the Tōkyō Igakkō, or Medical College, so as to form the Tōkyō Daigaku or Tōkyō University, comprising the four departments of law, science, medicine, and literature. The departments of law, science, and literature were combined in one institution, and one president was appointed for all three. Another president had charge of the medical department.

The medical department sprang out of the Igakujo,—an institution in Shitaya originally belonging to the Tokugawa Government, and revived by the Imperial Government in 1868. In the following year this school and the hospital established for the tending of the wounded in the war of 1868 were united under the name of the "Medical School and Hospital." Soon afterwards the combined institution was attached to the Daigaku, and received the name of "Daigaku Tōkō," or East College, because of its position to the east of the central Daigaku. In 1871 it shortened its name to "Tōkō," and in 1872 assumed the name of "Igakkō," or "Medical College in the First Grand Educational District," which title was again changed to "Tōkyō Igakkō" in the year 1874.

In 1876, the new buildings at Hongō having been completed, the college was transferred thither from Shitaya. In 1877 the college became the medical department of the Tōkyō Daigaku, or Tōkyō University. In 1881 the organization of the Tōkyō Daigaku was modified by the appointment of a president who should have control not only of the four departments of law, science, medicine, and literature, but also of the preparatory school. In September of 1884 the departments of law and literature removed to the new brick building in Kaga Yashiki, Hongō.

During the year 1885 various changes occurred. The central office of the university was transferred to a building in the compound at Hongō, the preparatory school dissolved its connection with the university and became an independent institution, the department of science also removed to Hongō, and the Tōkyō Hōgakkō or Law School, under the control of the department of justice, was merged in the university. Also in the same year the department of technology was created; and courses in mechanical and civil engineering, mining, applied chemistry, naval architecture, and kindred subjects were transferred to the new department from the science department. The course of politics in the literature department was likewise transferred to the law department, henceforward to be known as the "Department of Law and Politics."

The Kōbu Daigakkō, originally known as the "Kōgakkō," was instituted in 1871 in connection with the Bureau of Engineering in the Public Works Department of the Imperial Government. The institution was in 1872 divided into the college and the preparatory school. In 1874 the preparatory school was actually opened for instruction in Yamato-Yashiki Tameike; and in 1876 an art school was created in connection with the college.

In 1877 the Bureau of Engineering was abolished, and the college was thenceforth called the "Kōbu Daigakkō," or "Imperial College of Engineering." The same year witnessed the completion of the large new buildings at Toranomon, containing a central hall, classrooms, laboratories, dormitories, and the full equipment necessary for such an institution.

In June, 1882, the term of engagement of the head professor, Mr. Henry Dyer, expired. He first arrived in Japan in June, 1873, was appointed head professor, and occupied at the same time the chair of civil engineering. When he first arrived, the college was still in its infancy; and he set himself to plan the curriculum, and formulated the various college rules and regulations. He also planned the college building. As head professor, he discharged his duties with untiring diligence for the long pe-

riod of almost ten years. For these reasons, when he was leaving Japan, he was decorated with the third order of the Rising Sun, and was also appointed honorary head professor of the engineering college.

In 1882 the art school was discontinued. In 1885 the Department of Public Works was abolished,—an event which caused the college to be transferred to the control of the department of education.

In the late Tōkyō Daigaku and Kōbu Daigakkō, the following degrees were conferred on the graduates by their respective authorities: *Hōgakushi* in the department of law, *Rigakushi* in science, *Igakushi* in medicine, *Bungakushi* in literature, and *Kogakushi* in engineering.

On the 1st of March, 1886, the Imperial Ordinance No. 3 was promulgated for the organization of the Teikoku Daigaku, or Imperial University, and the Tōkyō Daigaku and Kōbu Daigakkō were merged in the new institution. H. E. Hiromoto Watanabe, then the governor of Tōkyō, was appointed president of the university. In April, curricula of instruction for the several colleges of the university were established. Each course extends over three years, excepting the course in medicine, which extends over four years. In the same month the Tōkyō Shokkō Gakkō (School of Industrial Technology) was placed under the control of the university. In November the five principal private law schools in the city were placed under the supervision of the university. A supervising committee for these schools was formed among the professors of the College of Law, who became responsible for the courses of instruction and the method of examining the students. In December of the same year a marine zoölogical station was established at Misaki, a town situated at Cape Miura, in Sagami.

In May, 1887, the Imperial Ordinance No. 13 was promulgated, establishing regulations for learned degrees; and in June of the same year by-laws connected with these regulations were issued by the minister of state for education. In July it was decided that graduates of the colleges should be entitled to call themselves *Hōgakushi*, *Igakushi* (*Yakugakushi* in the case of graduates in the course of pharmacy), *Kōgakushi*, *Bungakushi*, and *Rigakushi* respectively, according to the course which they had pursued; and that *Jun-igakushi* of the Tōkyō Daigaku, and graduates of the Kōbu Daigakkō who had not received degrees, should be allowed to call themselves *Igakushi* and *Kōgakushi* respectively, after obtaining the sanction of the president of the university, to whom a formal application must be made, and a history given at length of their professional career after graduation.

In October the Tōkyō Shokkō Gakkō was separated from the university. In March, 1888, the powers and duties of the president of the university were formally fixed by the minister of state for education. In the same month a notification was issued by the education department, regulating the income, from tuition fees and various other sources, of all educational institutions under the direct control of the department, with the object of supplying each with a capital fund. In May the university was released from the duty of supervising the five principal private law schools in Tōkyō.

The Tōkyō Observatory was established at Iigura in the month of June. This institution, formed by the amalgamation with the University Observatory, of the Astronomical Section of the Home Department and the Astronomical Observatory of the Imperial Navy, was placed under the control of the Imperial University, which was accordingly intrusted with the duty of publishing the Astronomical Almanac.

On July 31 the College of Engineering was moved to the new brick building just completed for its use in the compound at Hongō. On the 30th of October of the same year a temporary committee for the compilation of the national history was established. This was due to the disestablishment of the temporary board for the compilation of the national history in the Naikaku, and to the subsequent intrusting of the work to the Imperial University. On the 20th of December of the same year the College of Science was removed to the new building then completed.

The Imperial University is under the control of the minister of state for education, and depends for its revenue upon annual

allowances from the treasury of the Imperial Government. The tuition fees and other sources of income are allowed to accumulate year by year, so as to form a large fund. A certain portion of this fund is, however, to be paid out in some cases towards the current expenditure of the university, when the cases are of such a nature as to demand the outlay.

The whole university—viz., the offices of the university, the university library, the colleges of law, medicine, engineering, literature, and science, the First Hospital of the College of Medicine, and the dormitories of the colleges—is situated in the extensive grounds at Motofujichō, Hongō, Tōkyō, known as Kagayashiki. The Botanic Garden is located at Koishikawa, the Tōkyō Observatory belonging to the university at Iigura, and the Second Hospital of the Medical College at Shitaya, all within the city limits. The Marine Biological Station of the university is situated at Misaki, a town on the north side of the entrance to the Bay of Tōkyō.

THE CHEAPEST FORM OF LIGHT.¹

THE object of this memoir is to show, by the study of the radiation of the fire-fly, that it is possible to produce light without heat other than that in the light itself, that this is actually effected now by nature's processes, and that these are cheaper than our industrial ones in a degree hitherto unrealized. By "cheapest" is here meant the most economical in energy, which, for our purpose, is nearly synonymous with "heat;" but, as a given amount of heat is producible by a known expenditure of fuel at a known cost, the word "cheapest" may also here be taken with little error in its ordinary economic application.

We recall that in all industrial methods of producing light there is involved an enormous waste, greatest in sources of low temperature, like the candle, lamp, or even gas illumination, where, as has already been shown, it ordinarily exceeds 99 parts in the 100; and least in sources of high temperature, like the incandescent light and electric arc, where yet it is still immense, and amounts, even under the most favorable conditions, to very much the larger part.

It has elsewhere² been stated, that, for a given expense, at least one hundred times the light should in theory be obtainable which we actually get by the present, most widely used methods of illumination. This, it will be observed, is given as a minimum value; and it is the object of the present research to demonstrate that not only this possible increase, but one still greater, is actually obtained now in certain natural processes, the successful imitation of which we know of nothing to prevent.

It is now universally admitted that wherever there is light there has been expenditure of heat in the production of radiation, existing in and as the luminosity itself, since both are but forms of the same energy; but this visible radiant heat which is inevitably necessary is not to be considered as waste. The waste comes from the present necessity of expending a great deal of heat in invisible forms before reaching even the slightest visible result; while each increase of the light represents not only the small amount of heat directly concerned in the making of the light itself, but a new indirect expenditure in the production of invisible calorific rays. Our eyes recognize heat mainly as it is conveyed in certain rapid ethereal vibrations associated with high temperatures, while we have no usual way of reaching these high temperatures without passing through the intermediate low ones; so that, if the vocal production of a short atmospheric vibration were subject to analogous conditions, a high note could never be produced until we had passed through the whole gamut, from discontinuous sounds below the lowest bass, up successively through every lower note of the scale till the desired alto was attained.

There are certain phenomena, long investigated yet little understood, and grouped under the general name of "phosphorescent," which form an apparent exception to this rule, especially where

¹ Abstract of an article by S. P. Langley and F. W. Very, published in the American Journal of Science for August, 1890.

² See results of an investigation by S. P. Langley, read before the National Academy in 1883, and given in Science for June 1, 1883, where it is shown that in the ordinary Argand burner gas-flame indefinitely over 99 per cent of the radiant energy is (for illumination purposes) waste.

nature employs them in the living organism; for it seems very difficult to believe that the light of a fire-fly, for instance, is accompanied by a temperature of 2000° F. or more, which is what we should have to produce to gain it by our usual processes. That it is, however, not necessarily impossible, we may infer from the fact that we can, by a known physical process, produce a still more brilliant light without sensible heat, where we are yet sure that the temperature exceeds this. No sensible heat accompanies the fire-fly's light, any more than need accompany that of the Geissler tube; but this might be the case in either instance, even though heat were there, owing to its minute quantity, which seems to defy direct investigation. It is usually assumed, with apparent reason, that the insect's light is produced without the invisible heat that accompanies our ordinary processes; and this view is strengthened by study of the fire-fly's spectrum, which has been frequently observed to diminish more rapidly toward the red than that of ordinary flames.

Nevertheless, this, though a highly probable and reasonable assumption, remains assumption rather than proof, until we can measure with a sufficiently delicate apparatus the heat which accompanies the light, and learn not only its quantity, but, what is more important, its quality. Apart from the scientific interest of such a demonstration, is its economic value, which may be inferred from what has already been said. It therefore seems desirable to make the light of the fire-fly the subject of a new research, in which it is endeavored to make the bolometer supplement the very incomplete evidence obtainable from the visible spectrum.

As we may learn from elementary treatises, phenomena of phosphorescence are common to insects, fishes, mollusks, vegetables, and organic and mineral matter. Among luminous insects the fire-fly of our fields is a familiar example; though other of the species attain greater size, and perhaps greater intrinsic brilliancy, especially the *Pyrophorus noctilucus* Linn., found in Cuba and elsewhere. Its length is about 37 millimetres, width 11 millimetres, and it has, like *Pyrophori*, three light-reservoirs,—two in the thorax, and one in the abdomen. To procure this Cuban fire-fly, the aid of the Smithsonian Institution was sought, and through the kindness of Professor Felipe Poey of Havana, and Señor Albert Bonzon of Santiago de Cuba, in the Island of Cuba, living specimens of the *Pyrophorus noctilucus* were received during the summer of 1889.

After a preliminary spectral examination in Washington, it was found more convenient to continue the research at the Allegheny Observatory by means of the very special apparatus supplied by the liberality of the late William Thaw of Pittsburgh, for researches in the lunar heat-spectrum. Photometric measurements throughout the spectrum of the insect's light were also made.

Resuming, then, what we have said, we repeat, that nature produces this cheapest light at about one four-hundredth part of the cost of the energy which is expended in the candle-flame, and at but an insignificant fraction of the cost of the electric light or the most economic light which has yet been devised; and that finally there seems to be no reason why we are forbidden to hope that we may yet discover a method (since such a one certainly exists, and is in use on the small scale) of obtaining an enormously greater result than we now do from our present ordinary means for producing light.

HEALTH MATTERS.

Female Medical Students in India.

THE study of medicine is becoming very popular with the native women of India. At the close of the academic session in 1889, says the *Medical Record*, there were 24 female students at the Calcutta Medical College, 14 at the Campbell Medical School, and 5 at the Cuttack Medical School. At Agra, during the year, 7 young women received licenses to practise. At Lahore there were 19, and at Madras 39, female medical students, one of the latter being the first to take the degree of M.B. at the Madras University. There were also female students at the Grant Medical

College of Bombay, and at the Government Medical Schools at Poonah, Ahmedabad, and Hyderabad. The movement was initiated a few years ago by Lady Dufferin, the wife of the Viceroy of India. Madame Pim, a diplomaed surgeon from Paris, has settled down in Bangalore, and is doing a large practice among the Zenana ladies there. A Bangalore paper believes that there is ample room for a lady surgeon or two in the Mysore Province, and it is said that the Maharajah will offer a scholarship to any girl student of the Maharanee's College who cares to enter on a course of medical study at the Madras Medical College. It is also stated in the *Indian Medical Gazette* that a large number of female pupils at the Agra Medical School have just passed their final examinations. These include several students who were especially sent by the Durbars of Ulwar and Tezpur and the municipalities of Etah, Fyzabad, and Raipur.

Treatment of Diphtheria.

In the *Répertoire de Pharmacie* for July 10, 1890, it is stated that Dr. Babchinski was attending a case of grave diphtheria occurring in his own son, in which a rapid change for the better occurred coincidentally with the appearance of erysipelas on the face. The fever rapidly fell, the false membrane disappeared, and cure rapidly took place. Dr. Babchinski also states (*The Therapeutic Gazette*) that in several other cases he noted a great improvement coincident with the appearance of erysipelas, and in one of them the erysipelas occurred on the leg, and not on the face. These facts suggested to Dr. Babchinski the idea of inoculating diphtheria cases with blood taken from patients suffering from erysipelas, and he states that in several cases in which he employed this procedure cure resulted. Later on, he practised inoculation of other cases of diphtheria with cultures of the microbe of erysipelas in agar-agar, and likewise noticed the disappearance of the symptoms of diphtheria. He further adds, that, when the inoculations were made, all special treatment was suspended, and in no case did the erysipelas present any sufficient gravity to cause uneasiness. He concludes by stating, that, if his observations and experiences are confirmed, this treatment should rob diphtheria of all its dangers.

The Work of a Health-Officer.

Dr. Frank W. Wright, the health-officer of New Haven, in his annual report just issued, expresses himself on some important points as follows:—

"In making this report, I feel that I should express the opinion that it is the duty of the Board of Health to take as active measures to preserve the good health of the community as it does to suppress the spread of disease after it has made its appearance. I know that public sentiment is directly opposed to any progress, and always will be until sickness and death have caused serious havoc; and then the cry will go forth, 'Why has the Board of Health done nothing to prevent this?'

"It is urgently demanded, in justice to yourselves and by all who wish to have our city regarded as a sanitary locality, that your board should see that a proper bill is introduced before the next Legislature, more fully defining your powers, and granting power to you in such directions as seems to you necessary for the preservation of the public health.

"The code of plumbing laws now pending before the Court of Common Council, if adopted, will be a step in the right direction. I firmly believe that more sickness is caused in this city by poor plumbing than by any other single condition. This is proved by the fact that the death-rate is larger every month in those wards where the prevailing plumbing is rusted-out sheet-iron pipes, loose joints, and untrapped sinks, than in those wards where the plumbing is generally good. I have carefully prepared a comparison of the three wards where the plumbing is the poorest with the three wards that have the best plumbing. As the wards representing poor plumbing, I have taken the third, fourth, and seventh. For the year ending Nov. 30, 1889, the death-rate per thousand was 20.6, 16.4, and 20.8 respectively. In the wards representing good plumbing, the first, eighth, and tenth, the death-rate per thousand for the same year was 7.9, 12.8, and 13.1 respectively. To any fair-minded person this must be convincing."

LETTERS TO THE EDITOR.

* * * Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.

The editor will be glad to publish any queries consonant with the character of the journal.

On request, twenty copies of the number containing his communication will be furnished free to any correspondent.

The Rotatory Motion of Heated Air.

NOTICING that Professor Hazen questions, in *Science*, the rotatory theory of tornadoes, it occurs to me to publish an observation that I recently made, which may have some bearing on this subject. Not long ago, while watching the surface of a cup of hot tea, which contained some sugar, but no milk or cream, my attention was attracted to the phenomena presented on its surface. Close to the hot liquid, and covering it quite evenly, was a thin layer of condensed vapor. The air of the room was still, and I protected the film from my breath, as I watched it. I saw the film in constant motion. At one or two points at a time the vapor acquired two motions,—one in a whorl, and one progressive. In the former the motion was first visible at the exterior, in a circle a little more than half an inch in diameter. The broad part of each ray of the whorl appeared first, and afterward the parts near the focus were developed, and were rotated or twisted round the focus at a relatively rapid rate. As this took place, the whole whorl advanced across the surface of the liquid until the whorl disappeared, and the clear surface appeared without any film above it. Sometimes only one whorl was in sight, sometimes two appeared at once. This phenomenon was repeated until no more vapor was visible above the liquid.

As it appeared to me, there were here conditions favorable to observing the behavior of moisture-laden air over a super-heated level surface. Some condition which escaped notice must have determined the point at which a special motion was initiated; but the uniformity with which this developed into a centripetal rotatory and advancing movement was quite impressive. How far the conditions of the observation coincide with the conditions present in tornadoes, those who are competent to discuss meteorological questions may decide.

CHARLES W. DULLES.

Philadelphia, Sept. 20.

AMONG THE PUBLISHERS.

"THE Essentials of Medical Chemistry and Urinalysis," by Sam E. Woody, M.D., published by P. Blakiston, Son, & Co., has reached a third edition, which would indicate that the book, which is small, is filling its place.

—Another characteristic brochure by Professor Henry Drummond, under the title of "Perfected Life, the Greatest Need of the World," has just been issued uniform with the popular booklet "Love the Supreme Gift, or the Greatest Thing in the World." Both are published by Fleming H. Revell, New York and Chicago.

—We have received from Messrs. Dauchy & Co.'s Newspaper Advertisement Agency, 27 Park Place, New York, their "New Catalogue of American Periodicals," a volume of 624 pages. It contains a list of all newspapers, magazines, and other periodicals in the United States and Canada which insert advertisements, and is corrected up to Aug. 15 of this year.

—Messrs. Macmillan & Co. have just issued "The Parabola," being Part I. of "Geometrical Conics," by Rev. John J. Milne and R. F. Davis. Instead of following the usual plan, the authors have endeavored to make a continuous treatise as distinguished from a series of detached propositions. At the close of the book is a valuable collection of problems.

—Dr. Charles M. Andrews of Bryn Mawr College will publish in the October number of the *Annals of the American Academy of Political and Social Science* an interesting article on "Beginnings of the Connecticut Towns." The Constitution of 1639 has a wider than local interest, since it was the first written constitution, the prototype of Republican government on this continent. It is a question of no small importance, therefore, whether the Constitution was founded by the towns as such or by the people. This is the question discussed by Dr. Andrews. A painstaking study of

the facts leads him to the conclusion, in opposition to the late Alexander Johnston and many others, that Connecticut draughted its organic law on the theory "that the sovereignty of a State is in the people of that State."

—Another example of the rapid growth of chemical literature is shown in the appearance from the press of John Wiley & Sons of "Sugar Analysis," by Ferdinand G. Wiechmann, Ph.D. Dr. Wiechmann is instructor in chemical physics and chemical philosophy at the School of Mines, Columbia College, and is consulting chemist to the Havemeyers & Elder Sugar Refinery Company of Brooklyn. The work is intended as a handbook of instruction in schools of chemical technology, and for use in the refineries, sugar-houses, and experiment stations. Within the past few years many changes have been introduced in the methods of sugar analysis, and new methods have been devised, and, as is usual with such matters, the literature is scattered through numerous foreign journals. It has been Dr. Wiechmann's purpose to bring this new matter together into such shape as to make it available for those directly interested. The methods of analysis which he has selected from the vast wealth of material available have been chosen after long trial and practice under the supervision of the author. Instead of taking up for discussion, as is usual, the different products met with in sugar laboratories, such as raw sugars, refined sugars, liquors, molasses, etc., and describing for each in turn the determination of their constituents, the author has deemed it more expedient to discuss the methods of determining the individual constituents, as sucrose, invert sugar, water, ash, etc., independently of the products in which they may occur. He believes that by the adoption of this plan repetitions have been avoided. Examples have been inserted in the text to aid in the understanding of the principles discussed, and of the calculations. As is usual with such works, various references to original memoirs are given. The book is furnished with numerous tables, as is required in such a subject.

—The twentieth anniversary of *The Century* is celebrated by the publication of the next (November) number. *The Century* series of separate illustrated papers on the movement to California in 1849 and the events which preceded it, begins in the November number with a narrative, by Gen. John Bidwell, of the experiences of the first emigrant train to California. There is no part of the world, of equal civilization, of which so little has been divulged as of Thibet. A well-qualified American traveller, Mr. W. Woodville Rockhill, has recently returned from a journey through this the unknown heart of Asia, and will give in a series of illustrated papers the results of his travels and observations. For seven hundred miles of Mr. Rockhill's journey he passed through a country where no white man had ever set foot. Among the articles promised are some on "The Personal Traits of Lincoln," "Adventures of War Prisoners," "Minister Dallas at the Court of the Czar Nicholas," "Indian Fights and Fighters," "American and English Frigates in the War of 1812," "The Faith Doctor" (by Edward Eggleston), "Mmes. De Staël, Roland, and Récamier," "Pictures by American Artists," "American Newspapers," "Municipal Government in Europe and America," and "Present Day Papers." This last unique series of well-considered utterances by prominent writers, on the great questions of the day, will be continued during the coming year. The group has recently added to its own number, and now consists of the following: Charles W. Shields, Hugh Miller Thompson, Henry C. Potter, Charles A. Briggs, Theodore T. Munger, Washington Gladden, William Chauncey Langdon, Francis G. Peabody, Samuel W. Dike, William F. Stocum, jun., Seth Low, Edward J. Phelps, Richard T. Ely, William J. Sloane, and Charles Dudley Warner. The above list gives only a part of the contents of the new year, special announcements of features in preparation being reserved. Mr. George Kennan, who was interrupted in the preparation of his concluding papers, will, it is expected, before long give further chapters of the story of his travels in Siberia and Russia; Mrs. Van Rensselaer will publish her final papers on English cathedrals; and Mr. La Farge will give his views of art in general, and especially of modern and Western art methods, from the point of view of an Oriental residence.

—Messrs. Macmillan & Co. will publish early next month, in their Adventure Series, "The Buccaneers and Marooners of America" (edited and illustrated by Howard Pyle), being an account of the famous adventures and daring deeds of certain notorious freebooters of the Spanish Main. Mr. Gladstone's new book, entitled "Landmarks of Homeric Study," will be issued immediately by the same firm. The author says in a recent letter, "Please to bear in mind that this little work was planned for America. The form of it seemed to me more suited for an American public."

—Among the new books of C. W. Bardeen, Syracuse, N.Y., is "Home Exercise for Health and Cure." This is a translation of a German work by D. G. R. Schreber, M.D., which is said to have sold in Germany to the extent of 140,000 copies. The purpose of the book is to furnish a cheap, easily understood, and practicable system of physical exercise.

—Those interested in chemical analysis will find much to interest them in "Electro-Chemical Analysis," by Edgar F. Smith, just published by P. Blakiston, Son, & Co. The author is professor of analytical chemistry at the University of Pennsylvania. These electro-chemical methods of quantitative analysis are in the main

new, and are constantly being used to a greater and greater extent. Professor Smith has done a service in giving chemists this book, which is rendered the more valuable by a profuse but not obtrusive amount of reference to the literature.

—Those having classes in solid geometry should send to Macmillan & Co. for a copy of Hayward's "Elements of Solid Geometry." The author, who is a fellow of the Royal Society, and is senior mathematical master in Harrow, has produced a compact text-book which departs from the Euclid so beloved in England, and is likely to find many users on this side.

—The forthcoming visit of the Count of Paris to this country will no doubt excite great public interest, and *The Illustrated American* has endeavored to cater to this by a lengthy article, profusely illustrated with portraits and scenes with particular reference to the distinguished visitor's career in our civil war. Those who do not know *The Illustrated American* should buy copies for a few weeks, and they are sure to find matters of interest. The recent series of illustrations of French artists and writers at their work were of special value.

—Among the fall announcements of Messrs. Macmillan & Co. we note the following as of interest to our readers: "Wild Beasts

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